Description

Method and device for rolling a metal strip by means of a
5   skin-pass rolling stand

The invention relates to a method and a device for
rolling a metal strip by means of a skin-pass rolling
stand, the thickness of the metal strip being reduced by
10   the rolling in the skin-pass rolling stand. The skin-pass
rolling of steel by means of a skin-pass rolling stand
serves primarily to roll specific properties into the
steel by means of a slight reduction in thickness. In
particular, flat products produced from soft steels for
15   cold-working in accordance with DIN EN 10130 and DIN EN
10131, hot-rolled metal strip in accordance with DIN EN
10051, precursor material for electrolytic strip surface
treatment (DIN 17163-electrolytically galvanized, cold-
rolled strip and sheet), relatively high-strength steels
20   and phosphorus-alloyed steels with and without bake-
hardening effects in accordance with SEW 093 and SEW 094,
soft microalloyed steels in accordance with SEW 095,
galvanized strip (in accordance with DIN EN 10142),
electric sheet produced from unalloyed and alloyed
25   steels, non-grain-oriented, non-final-annealed in
accordance with DIN 46400 Parts 2 and 4 and cold-rolled
broad strip made from stainless, heat-resistant steels in
accordance with DIN 59381 and 59382 are suitable for the
skin-pass rolling.
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The skin-pass rolling of soft steels (steel strips) for
cold-working is carried out in particular with the aim of
eliminating the pronounced yield point of the steel
strip, improving the planarity of the steel strip and
35   setting a defined roughness of the strip surface.

for example the yield strength, the planarity or the roughness of the steel strip, by means of skin-pass rolling.

According to the invention, the object is achieved by means of a method or a device for rolling a metal strip by means of a skin-pass rolling stand in accordance with claim 1 or claim 9, respectively. The thickness of the

5 metal strip is reduced by rolling in the skin-pass rolling stand, the velocity of the metal strip when it enters the skin-pass rolling stand and the velocity of the metal strip when it exits the skin-pass rolling stand being set independently of the tension in the metal

10 strip. In this way, it is possible to set the desired reduction in thickness particularly accurately, so that metal or steel strip of particularly high quality is formed. This method according to the invention is so accurate that it is even possible to reduce the yield

15 strength in a steel in which a significant reduction of the yield strength is only possible when the thickness is reduced by an amount which lies within a very narrow range, for example between 0.475 and 0.525%. Accordingly, the invention is particularly advantageously used for

20 metal strips whose thickness is reduced by between 0.1% and 5%, advantageously between 0.1% and 1%.

In an advantageous configuration of the invention, the velocity of the metal strip when it enters the skin-pass

25 rolling stand and the velocity of the metal strip when it exits the skin-pass rolling stand are set with the ratio of the desired thickness of the metal strip when it exits the skin-pass rolling stand to the thickness of the metal strip when it enters the skin-pass rolling stand. The

30 reduction in thickness is usually given as the lengthening of the metal strip or the elongation ratio, i.e. in an advantageous configuration of the invention the velocity of the metal strip when it enters the skin-pass rolling stand and the velocity of the metal strip

It is an object of the invention to further improve the quality parameters of steels or steel strips, such as

when it exits the skin-pass rolling stand are set with
the ratio of the length of the metal strip when it enters
the skin-pass rolling stand to the desired length of the
metal strip when it exits the skin-pass rolling stand.

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In a further advantageous configuration of the invention, a means for setting the strip entry velocity is provided for the purpose of setting the velocity of the metal strip when it enters the skin-pass rolling stand, and a
5   means for setting the strip exit velocity is provided for the purpose of setting the velocity of the metal strip when it exits the skin-pass rolling stand, and a controller is provided for controlling the means for setting the strip entry velocity, and a controller is
10   provided for controlling the means for setting the strip exit velocity, a set value for the velocity of the metal strip when it enters the skin-pass rolling stand being fed to the controller of the means for setting the strip entry velocity and a set value for the velocity of the
15   metal strip when it exits the skin-pass rolling stand being fed to the controller of the means for setting the strip exit velocity, and in which the set value for the velocity of the metal strip when it enters the skin-pass rolling stand and the set value for the velocity of the
20   metal strip when it exits the skin-pass rolling stand are set at the ratio of the desired thickness of the metal strip when it exits the skin-pass rolling stand to the thickness of the metal strip when it enters the skin-pass rolling stand. The same effect is achieved by setting the
25   set value for the velocity of the metal strip when it enters the skin-pass rolling stand and the set value for the velocity of the metal strip when it exits the skin-pass rolling stand with the ratio of the length of the metal strip when it enters the skin-pass rolling stand to
30   the desired length of the metal strip when it exits the skin-pass rolling stand.

In a further advantageous configuration of the invention, the set value for the velocity of the metal strip when it
35   enters the skin-pass rolling stand is corrected as a

function of a measured value for the velocity of the
metal strip when it enters the skin-

pass rolling stand and of a measured value for the velocity of the metal strip when it exits the skin-pass rolling stand.

5   In a further advantageous configuration of the invention, the set value for the velocity of the metal strip when it

enters the skin-pass rolling stand is corrected as a function of a temporal mean of measured values for the velocity of the metal strip when it enters the skin-pass rolling stand and of a temporal mean of measured values

5   for the velocity of the metal strip when it exits the skin-pass rolling stand.

In a particularly advantageous configuration of the invention, the roll nip in the skin-pass rolling stand is

10   set as a function of the tension in the metal strip upstream of the skin-pass rolling stand and as a function of the tension in the metal strip downstream of the skin-pass rolling stand.

15   Further advantages and inventive details will emerge from the following description of exemplary embodiments. In the drawing:

FIG. 1   shows a known control arrangement for a skin-pass

20   rolling stand,

FIG. 2   shows an exemplary embodiment of an inventive control arrangement for a skin-pass rolling stand,

FIG. 3   shows a particularly advantageous exemplary embodiment for a control arrangement for a skin-

25   pass rolling stand.

FIG. 1 shows a known control arrangement for a skin-pass rolling stand 7 for the skin-pass rolling of a metal strip 1. The skin-pass rolling stand 7 has two working

30   rollers 10 and 11 and two support rollers 8 and 9. The metal strip 1 passes through the skin-pass rolling stand 7 in the direction indicated by arrow 6. A means for setting the strip entry velocity, indicated by the rolls 2 and 3, is provided upstream of the skin-pass rolling

35   stand 7. A means for setting the strip exit velocity,

indicated by the rolls 4 and 5, is provided downstream of the skin-pass rolling stand 7. In the present exemplary embodiment, the means for setting the strip entry velocity and the means for setting the strip exit

5   velocity are designed as a bridle. However, they may also be designed as levelers, S-rolls or coilers. A velocity v_i is imposed on the metal strip 1 upstream of the skin-pass rolling stand 7 by means of the rolls 2 and 3. A velocity v_o is imposed on the

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metal strip 1 downstream of the skin-pass rolling stand 7
by means of the rolls 4 and 5. To set the velocity v_o of
the metal strip 1 downstream of the skin-pass rolling
stand 7, a controller 21 is provided, to which a set

5 value $v*$ is fed. The controller 21 controls the rolls 4
and 5 in such a manner that the velocity v_o of the metal
strip 1 when it exits the skin-pass rolling stand 7
corresponds to a desired set velocity $v*$.

10 Tension-measuring rolls 12 and 13, which measure the
tension τ_i of the metal strip 1 upstream of the skin-pass
rolling stand 7 and the tension τ_o in the metal strip 1
downstream of the skin-pass rolling stand 7, are provided
upstream and downstream of the skin-pass rolling stand 7.

15 The values τ_i and τ_o, together with their corresponding
predetermined set values τ_i* and τ_o* and also a set value
v_{w*} for the velocity v_w of the skin-pass rolling stand 7,
are input variables for a tension controller 14. The
tension controller 14 controls the velocity v_w of the

20 skin-pass rolling stand 7. In addition, the tension
controller 14 emits a tension-dependent correction value
k_τ.

Moreover, in an exemplary configuration of the invention,

25 the tension-measuring rolls 12 and 13 have incremental
sensors (not shown), which measure the rotation of the
tension-measuring rolls 12 and 13. These measured values
are used to form a strip-lengthening value e, to which
the following relationship applies:

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$$e = \frac{V_{c,m} - V_{i,m}}{V_{i,m}}$$

where $v_{o,m}$ is the velocity of the metal strip 1 downstream of the skin-pass rolling stand 7 measured by the incremental sensor of the tension-measuring roll 13, and $v_{i,m}$ is the velocity of the metal strip 1 upstream of the

5 skin-pass rolling stand 7 measured by means of the incremental sensor of the tension-measuring roll 12. A value $v*(1-e)$, which has previously been added to the tension correction value k_τ, is fed to the controller 20 as set value for the velocity.

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Moreover, there is provision for the rolling force in the skin-pass rolling stand 7 to be set to a predetermined set value $\dot{F}_w$ by means of a controller 15.

For reasons of clarity, the feedback means for the controllers 15, 20 and 21 are not illustrated.

FIG. 2 shows an exemplary configuration of the invention, in which the velocity v_i of the metal strip 1 when it enters the skin-pass rolling stand 7 is set independently of the tension in the metal strip 1. In a particularly advantageous configuration of the invention, the velocity v_i of the metal strip 1 when it enters the skin-pass rolling stand 7 is set to a set value $v*(1-E*)$. In this case, $E*$ is the set value for the elongation e of metal strip 1.

Instead of the tension controller 14 shown in FIG. 1, a tension-monitoring means 22 is provided. The tension-monitoring means – which is advantageously designed as a tension controller with preceding dead band – emits an additional set value dF_w for the rolling force, instead of a tension-specific correction value k_τ, when the strip tension reaches the limit of its regulating range. The rolling force in this case remains as constant as possible.

FIG. 3 shows an advantageous exemplary configuration of the invention. In this figure, the exemplary embodiment shown in FIG. 2 has been supplemented with a thickness-correction controller 25. The thickness-correction controller 25 determines a correction value k_E which is fed to the controller 20 and by means of which, for example, the set value $v*(1-E*)$ is corrected.

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The thickness controller 25 determines the correction value k_E in such a manner that the temporal mean ç of the strip-elongation value e corresponds to one of the set values of the thickness reduction E*. The temporal mean ç

5   of the strip-elongation value e is formed by means of the functional block 26 in accordance with

$$\bar{e} = \frac{\bar{V}_{o,m} - \bar{V}_{i,m}}{\bar{V}_{i,m}}$$

where $\bar{V}_{o,m}$ is the temporal mean of the value $v_{o,m}$, i.e. the temporal mean of the velocity of the metal strip 1
downstream of the skin-pass rolling stand 7 measured by the incremental sensor of the tension-measuring roll 13, and $\bar{V}_{i,m}$ is the temporal mean of the value $v_{i,m}$, i.e. the temporal mean of the velocity of the metal strip 1 upstream of the skin-pass rolling stand 7 measured by the incremental sensor of the tension-measuring roll 13. The devices for forming mean values 27 and 28 are provided for the purpose of forming $\bar{V}_{o,m}$ and $\bar{V}_{i,m}$.